Lake Vermilion Minnesota

Minnesota DNR / Minnesota PCA Lake ID Numbers 69037800, 69037801, 69037802, and 6907803

Water Quality Technical Report

Northern Lakes Scientific Advisory Panel (NLSAP)

Prepared for

Water Legacy

Prepared by

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Summary

Water from the Minntac tailings basin drains to the Sandy River which is a tributary to the Pike River and Lake Vermilion. The Minnesota Pollution Control Agency granted water discharge permit No. MN0057207 to U.S. Steel for the Minntac tailings basin which contains no limits on sulfate pollution. The flux of sulfate into Lake Vermilion via the Pike River is measured in tons per day. In the absence of mine pollution, sulfate levels for EPA Ecoregion 50n lakes are almost without exception under 2 mg/L.

Lakes with greater than 10 mg/L sulfate concentration are impaired for wild rice.

This Water Quality Technical Report has been prepared to provide a survey of existing surface sulfate concentrations in Lake Vermilion. Because of the size, Lake Vermilion has been divided into three zones each with a unique Lake ID in the Minnesota Department of Natural Resources Lake Finder system – Lake Vermilion (lake ID 69037800), East Vermilion (lake ID 69037801), and West Vermilion (lake ID 69037802). MPCA surface water data also separately designates the Lake Vermillion Pike Bay area with lake ID 69-0378-03. Note that lake ID numbers are used in hyphenated and unhyphenated formats, for example 69-0378-03 and 69037803.

Samples for analysis of sulfate concentration were gathered on June 3, 2021 as explained below.

Sulfate concentrations in 6 of 10 of locations in Lake Vermilion (including sections with lake ID 69-0378-00, 69-0378-01, 69-0378-02, and 69-0378-03) were above 10 mg/L. Two sample locations in Pike Bay were significantly elevated with sulfate concentrations of 17.1 and 20.2 mg/L. The 4 locations with concentrations below 10 mg/L are geographically the furthest from Pike Bay, and of these 4 locations, 3 are within 1 mg/L of the 10 mg/L standard. One location tested in West Vermilion (lake ID 69-0378-02) had a sulfate concentration within 1.5 mg/L of the standard.

Locations and Methods

1. **Sampling locations.** Locations for sample collection were accessed by boat and included locations designated "Vermilion," "Vermillion -Pike Bay" "East Vermilion," and "West Vermilion" by the Minnesota DNR. The Minnesota PCA separately designates Pike Bay with lake ID number 69-0378-03. Maps from the Minnesota DNR LakeFinder web site are shown in Figure 1 and Minnesota PCA map for Pike Bay ID number 69037803 is shown in Figure 2. Locations where samples were collected are shown in Figure 3, and GPS coordinates and lake ID numbers for sampling locations are listed in Table 1.

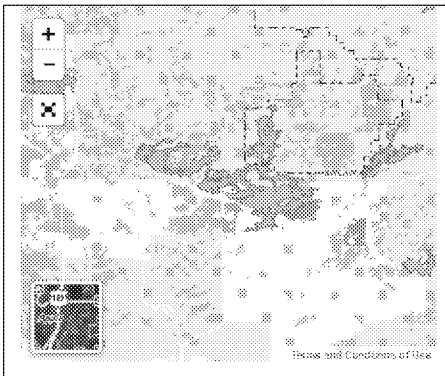

Figure 1a. LakeFinder: Vermilion, Lake ID 69-0378-00

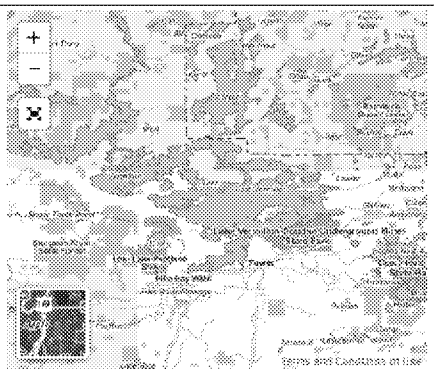

Figure 1b. LakeFinder: East Vermilion, Lake ID 69-0378-01

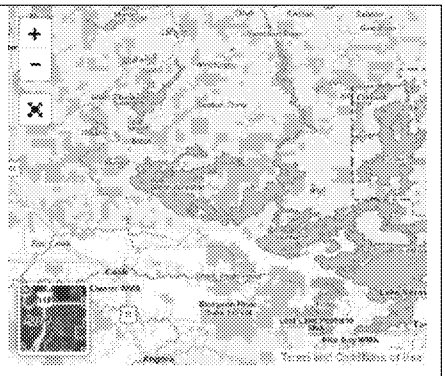

Figure 1c. LakeFinder: West Vermilion, Lake ID 69-0378-02

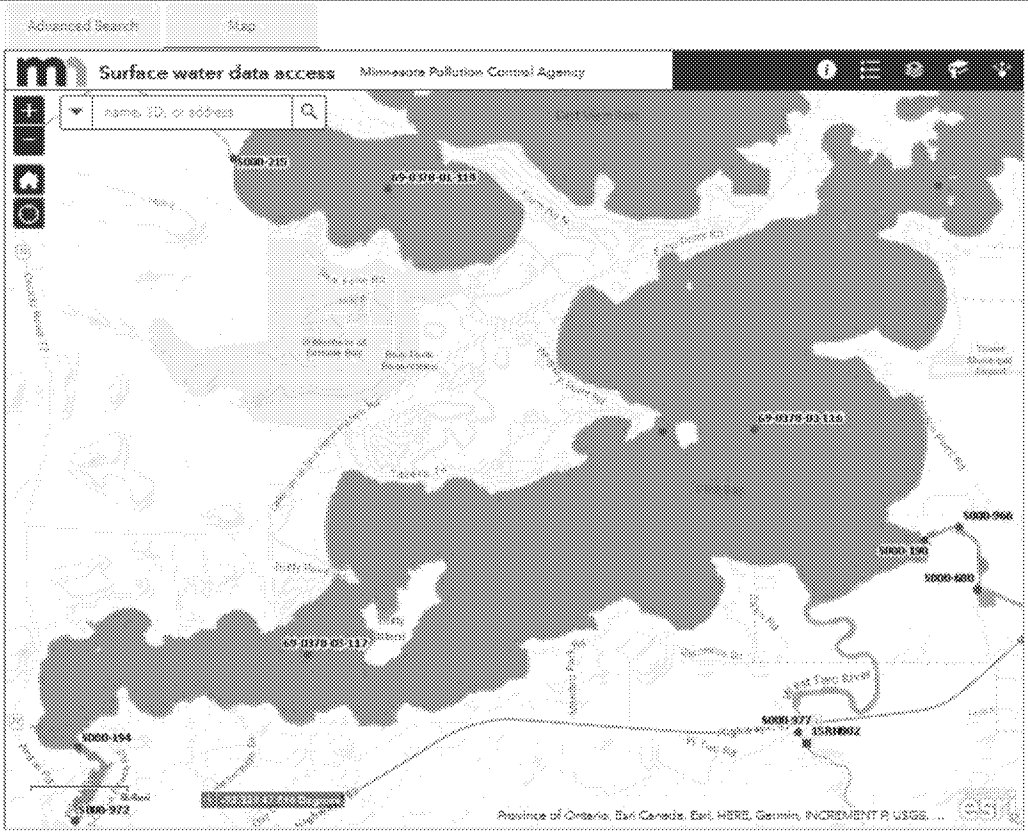

Figure 2. Minnesota PCA Lake ID number 69-0378-03, Pike Bay of Lake Vermilion

Table 1: Sampling Locations					
site	site description	lake ID number	date collected	latitude	longitude
1	Rice Bay	69-0378-01	6/3/2021	47.89389	-92.21750
2	Glenwood Lodge	69-0378-01	6/3/2021	47.89333	-92.24194
3	Glenwood Lodge	69-0378-01	6/3/2021	47.89333	-92.24139
4	Under Pike River bridge		6/3/2021	47.79167	-92.36806
5	Middle of big bay	69-0378-01	6/3/2021	47.85361	-92.31444
6	Between Isle of Pines and Pine Island	69-0378-01	6/3/2021	47.87333	-92.35000
7	Between Fectos Point and Black Duck Island	69-0378-00	6/3/2021	47.89083	-92.41611
8	Next to Oak Island	69-0378-02	6/3/2021	47.91889	-92.47083
9	Near Ely Island	69-0378-01	6/3/2021	47.83889	-92.26806
10	Near Ely Island	69-0378-01	6/3/2021	47.85278	-92.22667
11	Between Whiskey Island and Hoodoo Point	69-0378-03	6/3/2021	47.81806	-92.30722
12	In front of Duffy Island	69-0378-03	6/3/2021	47.80500	-92.34278

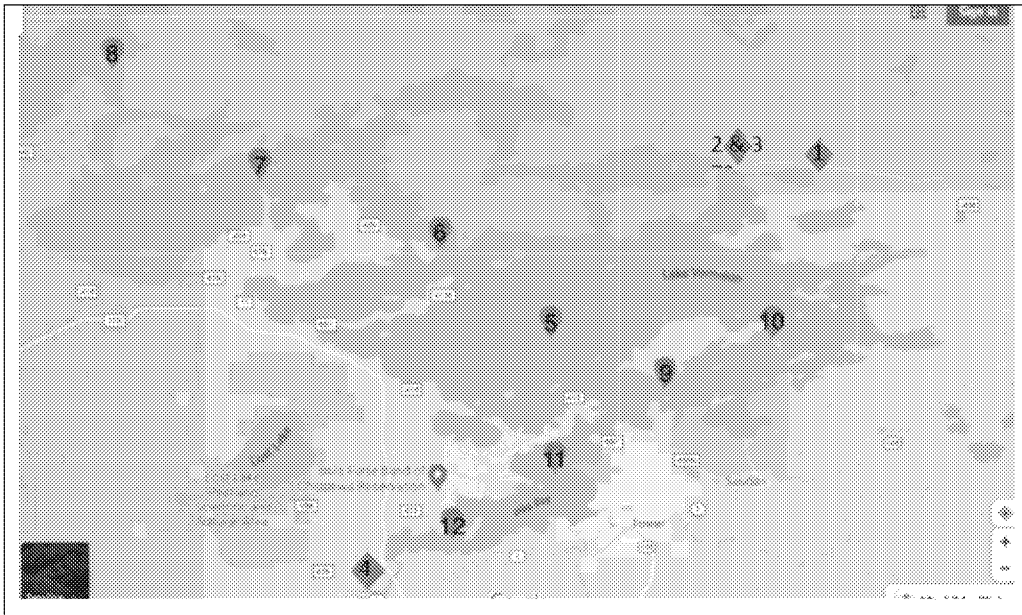

Figure 3. Sampling locations

2. **Sampling Methodology**. Samples were collected by Sue Okerstrom and Lucy Okerstrom at the water surface by immersing inverted sample bottles to 10 to 20 cm depth and turning over to fill. GPS coordinates were recorded at the time of sample collection using a GPS enabled smartphone and a screenshot was taken showing GPS coordinates, cell phone signal strength and time. Sample containers were either new polypropylene or new

polyethylene terephthalate bottles. After collecting, samples were stored between 4 C and 8 C in a secure location in the custody of persons personally known to the sample collectors including transportation to the lab where sulfate analyses were performed. Samples were analyzed within 28 days of collection and upon logging into the analytical lab, sample temperatures were confirmed to be between 2 C and 8 C.) Sample collectors were trained in proper sample collection including location mapping, bottle filling method, acceptable sample bottles, data collection, sample storage, and proper chain of custody.

3. **Sample Analysis.** Samples were analyzed by RMB Environmental Laboratories, Inc. 22796 Co Hwy 6, Detroit Lakes, MN 56501

   Sulfate concentrations were determined as sulfate using EPA METHOD 300.0 DETERMINATION OF INORGANIC ANIONS BY ION CHROMATOGRAPHY within 28 days of sample collection. The limit of quantification (LOQ) for the chromatographic method was less than 1 mg/L.

Results

Sulfate concentrations in mg/L are shown in Table 2. A map showing sample collection locations and sulfate concentrations is shown as Figure 4.

Table 2: Sulfate concentrations

site	site description	lake ID number	date collected	latitude	longitude	sulfate, mg/L
1	Rice Bay	69-0378-01	6/3/2021	47.89389	-92.21750	3.4
2	Glenwood Lodge	69-0378-01	6/3/2021	47.89333	-92.24194	9.8
3	Glenwood Lodge	69-0378-01	6/3/2021	47.89333	-92.24139	9.7
4	Under Pike River bridge		6/3/2021	47.79167	-92.36806	27.7
5	Middle of big bay	69-0378-01	6/3/2021	47.85361	-92.31444	11.8
6	Between Isle of Pines and Pine Island	69-0378-01	6/3/2021	47.87333	-92.35000	11.7
7	Between Fectos Point and Black Duck Island	69-0378-00	6/3/2021	47.89083	-92.41611	9.2
8	Next to Oak Island	69-0378-02	6/3/2021	47.91889	-92.47083	8.7
9	Near Ely Island	69-0378-01	6/3/2021	47.83889	-92.26806	12.4
10	Near Ely Island	69-0378-01	6/3/2021	47.85278	-92.22667	11.7
11	Between Whiskey Island and Hoodoo Point	69-0378-03	6/3/2021	47.81806	-92.30722	17.1
12	In front of Duffy Island	69-0378-03	6/3/2021	47.80500	-92.34278	20.2

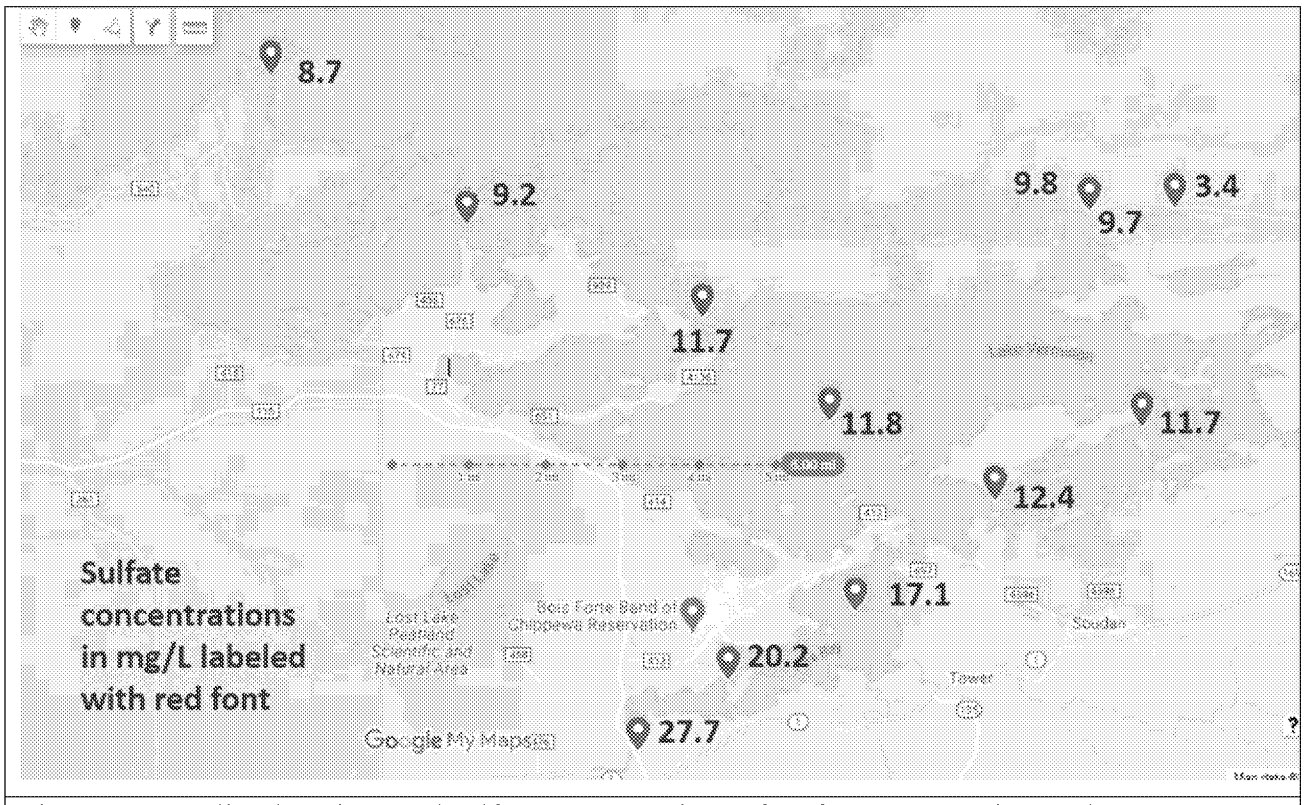

Figure 4. Sampling locations and sulfate concentrations of surface water grab samples. Sulfate concentrations in mg/L are depicted with red font for the blue pin location markers.

Conclusions

Sulfate ion concentrations in Lake Vermilion are significantly increased by sulfate pollution entering from the Pike River. In the absence of mine pollution, sulfate concentrations under 2 mg/L would be expected based on comparison to nearby unimpacted lakes. Sulfate concentrations in most of the lake are above the wild rice sulfate standard value of 10 mg/L. In Lake Vermilion, water moves from the mouth of the Pike River at the southernmost extremity of the lake and exits flowing north over the Vermilion Dam into the Vermilion River, with additional flow originating from several bays including Black, Wakemup, Rice, Armstrong, and Mud Creek Bay. The concentration of sulfate drops between Pike Bay and the Vermilion Dam due to the flow contribution of unimpacted water entering from bays other than Pike Bay.

Contributors

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